REPORT

ON THE

EXTENSION AND IMPROVEMENT

OF

The Harbour of Montreal;

BY ROBERT FORSYTH, C. E.,

ENGINEER FOR THE HARBOUR COMMISSIONERS;

WITH A

MEMORANDUM ON THE SAME SUBJECT,

BY CHARLES LEGGE, C. E.

ALSO,

THE ANNUAL

REPORT OF THE HARBOUR ENGINEER,

FOR THE YEAR 1860.

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1861.

REPORT.

HARBOUR COMMISSIONERS' OFFICE,
MONTREAL, 18*th July*, 1861.

ALEX. CLERK, ESQ.,
Secretary, Harbour Commissioners, Montreal.

SIR,

I received your letter dated 12th June last, with instructions from the Harbour Commissioners, to prepare a Report, embodying my opinion as to the best means of providing additional accommodation in the harbour for sea-going vessels, giving special attention to the question of wharfing the shoals opposite to the city.

I regret I have been unable sooner to give the time necessary for the consideration of so important a subject, in consequence of the press of shipping in port at the time I received my instructions, and it was not until yesterday the 17th inst., I received Mr. Legge's plan on the subject of wharfing the shoals in question.

Mr. Legge's memorandum embodies his views on the construction of wharves on the "Island Shoal," and in general they correspond with the suggestions of Thomas C. Keefer, Esq., to the Harbour Commissioners in a communication dated 14th January, 1854.

Mr. Legge, however, proposes to dredge out the body of the shoal, to make 10 feet water for wharfage inside, and 20 feet water along the outside or channel side; he also proposes to erect several wharves on the south side of the Canal.

That the trade of the Port is increasing is evident from the following arrivals from sea, during the last seven years, from the opening of the navigation to the 16th July in each year.

Year.	No. of Ships.	Aggregate Tonnage.
1855	69	20,789
1856	77	30,358
1857	83	33,650
1858	73	30,670
1859	71	40,017
1860	68	40,377
1861	274	128,717

During this season, and up to the 16th of July, there has been a greater number of vessels, and a greater aggregate tonnage, in the harbour of Montreal, than has ever been before during a whole season, from the opening to the close of the navigation, and this is a fact which proves, that the superiority of the St. Lawrence route is becoming better known to the shipping interests of both Europe and America.

From this rapid increase of shipping in the Port of Montreal, it is quite evident that the improvements in the harbour must be carried out on a large scale, so as to give the necessary facilities for trade, and to enable Montreal to compete with rival ports for the imports and exports of the West.

In carrying out these improvements it will be necessary to study economy, and at the same time to adopt such measures as will make the construction of additional works practicable in the shortest possible space of time.

I have prepared a sketch which I submit herewith, shewing the location of additional wharves as proposed by Mr. Legge, both on the shoals opposite to the city, and also south of the Canal in connection with the works of the "Montreal Railway Terminus Com-

pany," and "Montreal Hydraulic and Dock Company," and on which sketch I have drawn several suggestions which I consider to be the most effectual, practicable, and economical mode of increasing the harbour.

I have carefully prepared approximate estimates of the different improvements suggested; all these calculations are based on my actual experience in the harbour, both in construction and dredging, and I lay them before you so that the Commissioners may be guided in their discussions by facts and figures.

The wharfing of the Island Shoal is a subject which the Commissioners have had before them for a long time, and one which I have frequently considered, but from the number of objections to it, in comparison with wharfing and improving the edge of the river, I have never deemed it necessary to bring the subject under their notice. Now, however, as it is my instructions to give special attention to this subject, I beg to submit the following:—

Mr. Legge having been preparing plans for the "Montreal Hydraulic and Dock Company," and "Montreal Railway Terminus Company," says, his attention has been directed to the preparation of a plan for affording additional accommodation for the shipping in the present harbour of Montreal, and has submitted sketches with an explanatory memorandum on the subject.

The sites selected by him for the proposed improvements, are, however, in my opinion, more in connection with forwarding the schemes in which he is engaged, than the economical and immediate improvement of the present harbour.

The plan of construction submitted by Mr. Legge, viz., that of filling the cribs under water with stone, and above that level with dredging material, I do not approve of, as the general dredging in the harbour is "embedded sand," and "gravel with stones," and at the lower levels, "quicksand," so that were the superstructures filled with this material, the first time they were submerged, the sand would percolate through the stone filling below, leaving the superstructure partially empty and exposed to the ice, without any inside support.

In addition to this, he proposes to erect part of these wharves on piers 40 feet long, leaving spaces between them of 20 feet, and connecting the superstructure over the whole.

To a practical eye it must appear evident, that leaving these spaces for the water to wash out the filling into the channel, by the current and motion made by boats passing up and down, would seriously affect the stability of the work, as the whole is proposed to be of "open crib work," and all the back and superstructure filling of dredged material; in my opinion, in a very short time, so much would be washed away as would endanger the whole structure.

From my experience in the construction of crib work where it is exposed to a strong current, and at least six feet under water for five months in the year, I find it ought to be made close jointed, and filled with stones to the top; I cannot, therefore, accept Mr. Legge's estimates in comparison with mine, for the constructions proposed, but I shall submit an estimate showing the cost of the wharfage such as he proposes, and calculated on the same data as those constructions now being carried on in the harbour under my superintendence.

Mr. Legge suggests various widths for the proposed wharf round the Island Shoal, and I here submit his estimates of the cost as copied from his memorandum, viz.:—

	Feet wide.	Feet long.	Total cost.	Cost per sq. foot.	Cost per lineal foot.	Area sq. feet.
Island Shoal..	200	4340	$613,396	$0.71	$141.33	868,000
	150	4340	487,393	0.75	112.30	651,000
	100	4340	410,708	0.93	94.63	434,000
	240	2430	468,889	0.84	192.96	583,200
South side of Canal, Inner Wharf	100	1000	100,421	0.99	116.77	101,000
Outer Wharf..	100	1300	119,570	0.92	91.97	130,000

To the above estimates ought necessarily to be added, the expense of constructing the floating bridges proposed, the working of these, and keeping them in repair, also their removal every year to winter quarters. The first cost of these could not be estimated at less than one hundred thousand dollars ($100,000).

Mr. Legge proposes to let these wharves in lots, and to erect sheds thereon. These would have to be removed every Fall, and

erected every Spring, thus constituting a large item against any rent that might be received. Then again, the interest on cost of construction, together with tear and wear, would make the adoption of Sheds, as a general rule, very unsatisfactory.

The foregoing constructions might be very great improvements were it possible to do the work at a reasonable cost, in a short space of time, or if the Harbour Commissioners had no better locality in view, but from the nature of the location proposed, it would be a long and expensive mode of increasing our present wharfage.

The amount of dredging proposed on the Island Shoal, would occupy the two harbour dredges (Nos. 1 and 4,) for a space of about fourteen years, while the dredging necessary for the two wharves south of the canal, would employ the two dredges referred to, for about five years.

The access to the Island Shoal wharves would be by floating bridges, from "Russell Pier," "Island Wharf," "Grand Trunk Pier" and "Victoria Pier." These would, in my opinion, be found, not only inconvenient to those ships or shippers using the proposed wharves, but would prove a very serious inconvenience to the trade of the canal and harbour, from the fact of having them traversing the channel at the most unsuitable times, thereby causing endless confusion and interruption to the ascending and descending of vessels.

It is also proposed to dredge a channel 200 feet wide, and 20 feet deep (at low water), round the outside of this shoal, so that vessels ascending to the canal or upper part of the harbour could avail themselves of it.

On this part of the subject I would merely mention, that until the proposed dock at Point St. Charles is constructed, or a breakwater built to protect it from the current, it appears to me it would be impossible to navigate this channel in safety in the way proposed, as the current runs across, and would undoubtedly ground any vessel attempting that passage, or damage those which might be lying at the wharves on the outside.

Mr. Keefer in his communication previously referred to, says, "This new channel and the removal of the Island Shoal, would

" be almost indispensable, in order to form a proper approach to " the long locks, docks, and basins proposed at Point St. Charles." I would therefore suggest that as this part of the improvement may be considered more a part of the Hydraulic Dock Scheme, no doubt when found necessary, that company will execute the work.

The time which would be required to execute the large amount of dredging necessary, before the construction of the wharves on the Island Shoal or south side of the canal could be commenced, would be a serious objection to harbour extension in this direction, exclusive of the cost of such dredging.

The following is an approximate estimate of the cost of constructing the wharves on the Island Shoal, and the necessary dredging, as proposed by Mr. Legge, which I have computed on prices based on the actual work already executed in the harbour.

Island Shoal.

Dredging,	$276,931.00
Crib-work, &c.,	330,724.00
Backfilling,	116,521.00
Contingencies,	72,417.00
	$796,593.00
1st cost of floating bridges, 1 year,	100,000.00
	$896,593.00

In reference to that part of my instructions regarding the plan of the proposed City Terminus, as submitted by the Hon. John Young, Chairman of the "Montreal Railway Terminus Company," I consider the permission asked for by that company, is very nearly the same as was granted to the Grand Trunk Railway Company by special agreement entered into between that company and the Harbour Commissioners, whereby the latter had a certain wharf to build, with a proportion of the necessary filling to provide.

The plan suggested by Mr. Shanly, however, contemplated a connection between the rails and the present harbour, which is in Mr. Legge's opinion, "even in a commercial point of view impolitic," and he considers such connection at that point, "merely an engineering impracticability."

I must take exception to Mr. Legge's views on this part of his plans, as I consider the connection of our present wharves, (the Harbour of Montreal,) with the railway system of the country, to be an object of paramount importance in the construction of a city terminus of the railways in Montreal, and that the said connection has not the insurmountable difficulties represented by Mr. Legge.

The mode of passing over part of the harbour at the canal by a viaduct, seems a convenient arrangement, as that place will be still available for the general traffic to pass under the girders.

I would, however, recommend the crossing of the canal in a more oblique direction, by which means a greater curve could be introduced on the south side, and a connection with the harbour more easily effected.

Additional berths for ships referred to in connection with the city terminus, is a matter of comparative estimate. Mr. Legge proposes two wharves, one at the mouth of the canal behind lock No. 1, and to be 1000 feet long, to be sunk in 20 feet water; also a wharf 1300 feet long on the outside of the proposed tail-race from the manufactories in Mill Street. This latter wharf is a part of the Hydraulic and Dock Scheme, having a most inconvenient communication with the city, by means of a Floating Bridge. The amount required for its construction, could, doubtless, be more advantageously expended in other and more convenient parts of the Harbour.

Any wharves, however, constructed at the expense of the Commissioners should be held solely under their own control, or let out by special agreement, and for specific purposes; a right of way should also be secured at all times for the Commissioners to pass to and from them.

The cost of constructing the wharf at the mouth of the canal, (1000 feet long, and in 20 feet water,) and in connection with the city terminus, would be about one hundred and twenty-two thousand, three hundred and forty-one $\frac{61}{100}$ dollars, ($122,341.61.) Mr. Legge's estimate for same being $100,421.00.

The wharf suggested on the south side of the proposed tail race from the manufactories in Mill Street, and being part of the Hy-

draulic and Dock Scheme, would cost about one hundred and sixty six thousand, eight hundred and ninety $\frac{29}{100}$ dollars, ($166,890.29.) Mr. Legge's estimate for same being $119,570.00.

In extending the wharfage of the harbour, the inconvenience of the delay necessary to prepare sites for new wharves by dredging, has been frequently very much felt, (this year in particular.) I have therefore been obliged to turn my attention to the extension of our wharves where such dredging *may* be wholly unnecessary, and at the same time, where a small amount of dredging will effect a considerable saving in construction, without interfering with the progress of the work.

These two objects I can combine by the extension of "breast wharves" along the river bank, from the lower end of the "Military Wharf" downward towards "Hochelaga Bay," and by extending piers into the current, at distances of five hundred feet from each other. A large amount of additional wharfage can thus be had in a short space of time, as with the exception of a small spot at the lower end of the Military Wharf, these breast wharves would be built on the bank line of 20 feet depth at low water, and the piers would necessarily extend out to an average depth of 22 to 25 feet water.

In this way a large addition of 20 feet wharf room would be gained between "Monarque Street Wharf" and "Military Wharf," amounting to 4370 lineal feet at the following estimate of cost, viz. :—

Dredging,	$ 22,565.00
Cribbing, &c.,	225,090.00
Backfilling,	27,078.00
Contingencies,	25,267.00
	$300,000.00

In my last annual Report to the Harbour Commissioners, dated 31st December, 1860, the following statement of the wharfage in the harbour appears, shewing the extent of such at the different depths of water then at these wharves, not including "Monarque Street" or "Hochelaga" wharves.

"Statement of the wharfage in the Harbour of Montreal, 1860."

20	feet	deep	and over		lineal feet,	1748
18	"	"	under	20	" "	1508
15	"	"	"	18	" "	2219
10	"	"	"	15	" "	5834
5	"	"	"	10	" "	227
					Lineal feet.....	11,536

By the above statement it will be seen, that at the date of the Report referred to, there was only 1748 feet of 20 feet wharfage then inthe harbour, but by the adoption of the plan of wharfing the edge of the St. Lawrence in the way I propose on the accompanying plan, 18,370 lineal feet of 20 feet wharfage can be obtained, between the lower end of "Military Wharf" and "Hochelaga Bay," without the assistance of the dredges, excepting in the small place already mentioned, or where it would be found economy to use them, without retarding the construction.

This additional wharfage with our present harbour, would give over 6 miles of wharves in the harbour of Montreal, and capable of being still more largely extended when found necessary.

The improvement and extension of the wharfage in the present harbour for sea-going vessels, may be to a very large extent increased by the judicious employment of the present dredging plant belonging to the Harbour Commissioners as suggested in my annual Report already referred to, by dredging out the present basins, and repairing the old wharves, to make them available for the improved draft of water. In proof of this I would state that upwards of one hundred sea-going vessels were at one time berthed in the harbour during the high water this Spring, so that if the water was deep enough, the same number of vessels could be accommodated at low water, and with the additional pier now being constructed 2200 feet long, at the end of "Victoria Pier," wharfage would be had for as large a fleet as was here this spring, where all the vessels might have working berths. It is however evident, that additional wharfage is necessary, and I would recommend the foregoing plan of wharfing the edge of the river downwards, as trade demands.

There are other improvements as well as additional wharves, required to put Montreal in a position to compete with her rival ports. viz.—

Railway communication along her wharves, and mechanical contrivances, for the expeditious and economical handling of grain, and other freight.

The railway communication I propose to make in connection with the projected City terminus at McGill street (or from Bonaventure street if necessary) is by bringing the track along Commissioners and Common street, and descending to the level of the wharves. Mr. Legge in his Report " to the Hon. John Young, Chairman of " Provisional Committee for obtaining plans of Hydraulic Docks " and City Terminus G. T. R." says: " It may perhaps be " urged, that the plan referred to embraced a connection of the " railway with the present harbour, and that by this means a large " amount of through traffic each way would be taken directly to " and from the vessels, and do away with the necessity of cartage. " In answer to this it may stated there are so many difficulties in " the way of effecting this union as to render it nearly an engineer- " ring impracticability, and even in a commercial point of view " impolitic, but as the discussion of this part of the general " question will be fully gone into in a more extended report at a " future period, it may suffice at this time to observe, that the " height at which the rail over the canal must be placed so as to " be beyond injury from the ice will be at least 18 feet above the " level of the wharves, over which steep incline all traffic would " require to pass.

" The most serious objection, however, is the sharp curvature " from the end of the bridge to the line of the harbour, and un " fortunately located on the same steep incline as well as the large " amount of valuable ground that would be occupied, or rendered " useless for commercial purposes, by the embankment carrying " the rail down to the lower level, the total want of room for sid- " ing accommodation when on that level, the interference with " ordinary traffic between the harbour and City, and at the same " time useless during the winter months from being covered with " water. The proposed line along Commissioners street in front of " the City is open to many of the same objections.

" In fact, the more reflection bestowed on the subject, the " stronger becomes the conviction that both nature and art have " forbidden the iron bands of union between ship and rail traffic " being consummated in this direction."

By the foregoing quotation it is evidently Mr. Legge's intention, to set aside the present harbour as incapable of improvement for railroad purposes, but had he had the opportunity of knowing the proposals urged upon the Commissioners, for the necessary repairs of the old narrow wharves towards the canal, with a view to make the necessary arrangements for railway tracks thereon, I presume it would have materially changed his views.

The combination of " nature and art " against the harbour of Montreal as represented by him, will have to be met by carrying out the proposals referred to.

The necessity for repairing the piers and basins of the upper part of the harbour, has been frequently urged upon the Commissioners, and at the same time increasing the breadth of wharf room to enable them to have space enough for 2 or 3 railroad tracks, without interfering with the regular traffic of the harbour.

Commissioners and Common streets along the city front, are too narrow to be used for railway purposes, without interfering with the city traffic, but as the revetment wall has been built much too weak to retain the bank behind, the frost is annually pushing it over. It is now in several places over the perpendicular, and will in a very short time require to be rebuilt. I therefore propose to remove the revetment wall outwards, so as to give Commissioners and Common streets a full width of 70 feet from the present street line, and to bring the railroad track from the end of the proposed bridge over the canal, with a 500 feet curve, on Common street, and run along that street to the junction with Commissioners street, where I would run down an incline to the level of the wharves, then up or down the harbour, as might be necessary, and to have three tracks for the general traffic on the level of the wharves.

While this alteration is being made, it might be considered advisable to raise the level of the revetment wall, above that of the flood of last spring.

The expense of widening the above streets, ought to be met in part by the City Corporation as the advantage to the citizens would be very great.

To make a proper connection on Common street, it would be necessary to acquire a narrow strip of ground from Mr. Logan's property, between Youville and McGill streets, to obtain sufficient space to curve round from the canal bridge, but as before stated, had Mr. Legge adopted a more oblique crossing with his bridge over the canal, it would have made this connection more practicable and economical.

I propose to continue Commissioners street at 70 feet width to "St. Nicholas Tolentine street," or lower end of Military Wharf, where I would adopt the plan of the Boulevard proposed and submitted by the Harbour Commissioners to the City Corporation on the 16th February, 1859. From this point I would extend Commissioners street 60 feet wide (as laid down on accompanying plan,) as far down as "Hochelaga Bay," making this level over the highest flood mark, and running two lines of rails along the same, while the latter would be extended down on the lower level, as far as the wharves would be constructed.

At the lower end of the harbour, or Hochelaga Bay, I would make an incline down to the level of the wharves, so that in the event of a railway to communicate with the Ottawa district, or the North Shore railroad being constructed, they would have a connection with the City and harbour from the East.

In these views I am fully borne out by W. Shanly, Esq., C. E. who in his report to the Harbour Commissioners of Montreal (on a City Terminus) dated Oct. 4th, 1859, says:—"There is "one other point to which I have as yet made no allusion, "but which is of too much importance to be overlooked in fairly "discussing the general question of railway extension, that is, "the necessity of keeping in sight the means of reaching the "Eastern end of the City, and Hochelaga Bay, whenever it "may be found advantageous to commercial interests to do so.

"In the event of the North Shore line to Quebec being con- "structed, or any other lines from the north and north-west termi- "nating in Montreal, there can be no question that their proper

" entry into the City will be considerably east of the centre, and " their first access to the river below the present system of " wharves.

" Railway entry from the West, so as to include a harbour line, " is, I have already recorded my opinion, limited to the Bonaven- " ture street route and that by Mill street, to both of which one " mode of direction with the wharves is common.

" Once at wharf level the line of rails can be extended east- " ward, *pari passu*, into the wharves as they advance in that " direction, at a rate of cost just the same as laying rails on any " other dead level would be;—some two dollars per foot forward.

" A wharf line, however, would be of no use during the reign " of the ice, and to provide for the required intercourse between " the west and east quarters of the city during that season, I " would lay a track along Commissioners street as far as to a short " distance below the " Quebec Gate Barrack;" thence continuing " it, on a terraced road way, along the face of the river bank, to " Hochelaga Bay, or as far eastward as required.

" A track along Commissioners street would be much less of a " public obstruction than one along Craig street, for instance.—

" It would be chiefly called into requisition in the winter, when " the street is least of a thoroughfare, and crossed not once in the " day for ten times that it is during the season of navigation.

" No such cheap or convenient and safe plan of rail connection " between the upper and lower sections of the port of Montreal can " be devised as that above traced,—by way of the wharves for our season of the commercial year, and, secondly, along Commissioners street, (from the canal basin) to the Military Hospital, and so on, " along the river to the Bay below."

Next to additional wharf accommodation, and railway communication are mechanical contrivances, for the more economical handling of grain or other freight. These can be arranged in various ways, and in the first place, I would again recommend the plan of constructing permanent grain stores, and elevators, on the present wharves, as submitted by me to the Harbour Commissioners in a communication dated January 3rd, 1861, and on which no action has been taken. Since then another plan has sug-

gested itself to me by which the present harbour can be made to afford all the facilities which are possessed by the grain ports of the United States, and by this I propose to make the whole of Commissioners and Common streets, opposite to the harbour, as available for grain and produce stores, as the warehouses on the edge of the canal basin, with this advantage over the latter, that no transshipment by barge will be necessary to convey grain stored in winter, or delivered by rail in summer or winter, into the ocean vessel for exportation.

Making grain stores on Commissioners and Common streets, will necessitate the use of steam power, and the erection of suitable warehouses for the purpose of storing produce.

For working the grain trade I propose to erect a series of truss-frame work pillars, of light angle iron or timber, at intervals from the building across the street, and over to the edge of the wharf, on the edge of which would be erected an elevator, somewhat similar in design to the machinery used in the floating elevators now in use, and driven by a horizontal shaft or belt from the main building along the top of the light frame work, and covered with a moveable roof to protect it from the weather, under which roof I propose to have two hollow belts, to carry grain either from or to the ships, as may be desired.

By this arrangement, grain could be elevated from a barge and spouted into a ship, at the same time, it could be spouted direct from the warehouse into the same ship, by the belt, also one belt could be carrying grain into the store while the other would be carrying out to the ship.

The expense of removing this simple construction every winter, and again erecting it in spring would be a small item, in consideration of the advantages to be derived therefrom.

A line of cars could be brought along the wharf level close to the elevator, and the grain run direct from them into a hopper. The same could be done on Commissioners street level, and run from the car bottom into the building, then elevated and distributed where wanted.

From the foregoing it appears to me evident, that as the present harbour is so capable of being largely extended, both in

wharfage space, and other facilities, it would be the most economical policy, for the Commissioners, to extend the wharves from year to year, as far in the direction which I have recommended, as in their opinion the trade may demand; but it would be injudicious to construct wharves to such an extent, as will enable every ship, barge and batteau that may come to the port, the full length of her side at a wharf berth. Such is not the case (so far as I can learn) in any large port in the world, and as there is only about 6 months in the year, of active business at the wharves in Montreal, it is a matter for serious consideration, that the revenue received be sufficient to meet all necessary expenses, and interest on expenditure for constructions.

Ship owners do not expect to have their ships placed at a wharf berth immediately on arrival, but do as in other ports "Wait their turn."

Having duly weighed the subject of improving the present harbour, I am of opinion, it would be impolitic for the Harbour Commissioners to embark in the construction of wharves which would be expensive, inconvenient to be got at, and exceedingly tedious in construction, while they have the facilities for largely increasing the present harbour by dredging it, and by constructing economical and convenient breast wharves and piers along the river bank.

I am, sir,
Your obedient servant,

ROBERT FORSYTH,
Eng. Harb. Com.

MEMORANDUM

OF

MR. CHARLES LEGGE, CIVIL ENGINEER.

Containing his plans and suggestions for providing additional accommodation for shipping in the Harbour of Montreal, alluded to in the foregoing Report of Mr. Forsyth, Harbour Engineer.

The attention of the undersigned having been directed to the preparation of a plan for affording additional accommodation for shipping in the present harbour of Montreal, the accompanying sketches have been prepared with that view, and are now submitted with the following explanatory remarks.

The points selected as the sites for the proposed improvements are at the foot of the Lachine Canal and in the Island Shoal opposite the central portion of the city.

At the first named point it is suggested that wharves be constructed on each side of the contemplated Tail Race, belonging to the Hydraulic and Dock Scheme furnishing when completed a total length of wharfage of 2,300 feet; being 1,000 feet on the north or city side, and 1,300 feet on the south or dock side. The intervening space about 230 feet in width to be dredged to a depth of 20 feet, and the material so obtained placed behind the cribbing on each side, furnishing a total width for the entire length of 100 feet on which to erect temporary sheds, &c., for the reception of flour, goods, &c.

The inner wharf will be connected to the main shore by a cart road passing under a bridge provided for that purpose in the railway embankment, and following the embankment on a ramp road 30 feet wide, to Windmill Point; a second road can also easily be obtained, by following the canal embankment and passing underneath the railway swing bridge.

Access to the outer wharf will be had by means of a floating pontoon at the upper end, 200 feet in length, and 30 feet wide, to be put in position in the spring and removed to a place of security on the close of navigation.

These wharves will be raised 10½ feet above summer level, or 2 feet above those of the present harbor.

The constructions will be of the most solid and substantial character, to enable them to resist the impact of ice; the cribbing 30½ feet in height, will possess a width of 21 feet on the bottom and 18 feet on the top, with a front batter of 1 in 10, and plumb in rear; filled from the bottom to the level of summer water, with stones, and from thence to the top with material from the dredging. From the distance of one foot under low water, to the top, the exposed face will be sheeted with 4 inch tamarack planks, securely fastened to the timbers of the superstructure with iron straps and spikes. The top of the wharf, over the cribwork, will also be protected in a similar manner with tamarack planks, and the remaining portion of 82 feet in width, covered with pine plank 3 inch thick resting on timber sills placed 4 feet apart, secured to subsills in order to prevent the floor being disturbed when covered with water and ice during the periods of inundations. The outer slopes will be covered with a rip-rap wall 2 feet thick to protect the embankment against the cutting action of the current.

The cost of the work at this point will be about as follows:

	Cost.	Cost. Per square foot.	Cost. Per lineal foot.	Length of Wharf. feet.	Square feet.
1st wharf near city,	$100,421	$0.99	$116.77	1000	101,000
2nd wharf on opposite side,	$119,570	$0.92	$ 91.97	1300	130,000
Total	$229,991			Ft. 2300	231,000

costing on an average $0.95 cents per square foot of surface.

By running a street 40 feet wide in rear of each wharf, and dividing the space intervening between it and the front into lots, furnishes 11 of 200 feet in length by 60 feet in width, or equivalent to 12,000 square feet each.

These lots could be advantageously leased to parties engaged in shipping business, and a revenue derived therefrom, which would go far towards meeting the interest on the first cost, leaving the harbour dues from vessels occupying berths to pay the balance, and form a sinking fund for the liquidation of the debt.

Temporary sheds can be erected either by the harbour authorities or by those parties leasing the lots, for protecting flour and general merchandise from the weather.

The proximity of those wharves to the manufacturing and milling establishments at the lower entrance of the Lachine Canal, the Grand Trunk Railway, and the warehouses on the city side of the canal, as well as being essentially land wharves, will enhance their value materially ; while at the same time constituting the first step towards the Hydraulic and Dock Scheme, of which they will constitute a portion.

The second point selected as a site for proposed harbour extension, is the "Island Shoal" opposite the city.

This shoal forms a continuation of the Point St. Charles one on which the projected dock harbour is located, being connected with it by means of a narrow neck 250 feet in width, over which there is not less than 6 feet draft of water. From the point of this connection, the shoal gradually widens, and extends downwards to a point opposite Bonsecours market, a distance of about 2,400 feet, the average width being 1,100 feet; on the inner side, or between it and the city, is the present channel of 300 feet in width, and 20 feet draft of water, while on the opposite or south side, with the exception of the connecting neck before referred to, the draft of water ranges from 11 to 20 feet, affording facilities for a second navigable channel at a moderate outlay, for vessels leaving the hydraulic dock when built ; this will surround the entire shoal with 20 feet water, and admit of a portion of it being elevated above the water to form the proposed improvement.

To carry the work out in an economical manner and at the same time to attain the greatest amount of service room for shipping and transacting business, should be the governing considerations in determining the character of the structure to occupy the shoal, at the same time keeping in view the necessity of bringing into use the different sections of the work so soon as completed and the whole plan so arranged as to admit of extension from year to year in order to keep pace with the business requirements of the port, without in any manner marring the general character of the whole when eventually carried out to its full extent. To accomplish this, various plans could be suggested, the most efficient, in the opinion of the undersigned, being one or other of the following.

The sketch as laid down on the plan, shews a scheme, which if carried out, will be second only to the hydraulic and dock one, in point of extent, and facility afforded for exchange of cargoes. It comprises a solid wharf 200 feet in width, raised 10 feet above summer level, and running in the form of a horse shoe or magnet, surrounds the shoal on the inner, upper and outer sides, leaving the lower side open. The outer side of the wharf in its entire length, will rest in 20 feet water, and be made up of solid crib work, built and protected in the most approved manner, the cribbing on the inner side, will rest in 10 feet water, bordering on an inner channel dredged to that depth, for the use of the river craft—

the space intervening between the internal and external cribs, of 164 feet in breadth, will be filled up to the level of the wharf by the dredging from the various channels, and securely planked over.

The construction will commence at the upper end and produced downwards as required, forming when completed, a deep water wharfage of 4719 feet, with river or 10 feet water wharfage of 4005 feet—the superficial area will amount to 868,000 square feet, furnishing a road of 50 feet in width around the entire wharf and 150 feet in width for service ground. This space (within the letters A B C D E F I K on the plan) will give 44 lots of 75 feet by 200 feet, each, in the event of the road being placed in the centre of the wharf; or, 22 lots 150 feet by 200 feet each, should the location of the road be on either side.

The cost will amount to about $613,396, being $0.71 per square foot, or $141.33 per running foot; this amount though large in the aggregate is the cheapest in proportion to the extent of accommodation furnished, of either of the plans devised.

In another plan estimated, the width is reduced to 150 feet, with the same extent of wharfage as the previous one—the amount of the estimate is $487,393, with a superficial area of 651,000, at a cost per square foot of $0.75, and $112.30 per lineal foot.

A third plan, still further reduced in width to 100 feet, but with the same length as before, foots up to $410,708, and an area of 434,000 square feet, making each foot cost $0.93, but with a diminution to $94.63 per running foot.

Another modification is to embrace only that portion of the plan within the letters A B C D, making it 240 feet in width, and dredging the channel exterior to it to 20 feet instead of 10 feet as in the previous cases; this channel would take the place of that previously mentioned as the one to be formed by dredging across the neck of the shoal.

The entire wharf would then be surrounded by deep water, and furnish 5345 feet of wharfage at a cost of $468,889, with a superficial area of 583,200 square feet, making each foot cost $0.84, and every lineal one $192.96.

Abstracting all the foregoing results, we find the following:

ISLAND SHOAL.

	Ft. wide.	Ft. long.	Cost.	Per sq. ft.	Per lineal ft.	Area.
Wharf	200	4340	$613,396	$0.71	$141.33	868,000
"	150	4340	$487,393	$0.75	$112.30	651,000
"	100	4340	$410,708	$0.93	$ 94.63	434,000
"	240	2430	$468,889	$0.84	$192.96	583,200
FOOT OF CANAL.						
Inner wharf	100	1000	$100,421	$0.99	$116.77	181,000
Outer wharf	100	1300	$119,570	$0.92	$ 91.97	130,000

From the foregoing it appears that plan No. 1 has the preference over its three competitors, in so far as cost per square foot is concerned, and

must therefore be looked upon with the most favourable eye. The accompanying detailed drawings of crib work, &c., will shew the manner in which it is contemplated to execute the work, but as it is of so simple a character, and so well understood, no further reference need be made to it here.

The main object to be served by the construction of the proposed wharf, is the reception of freight from the inland craft, and placing it in such position as to admit of being transferred to the transatlantic vessels without cartage and other incidental expenses attending the present landing of goods, &c. A number of sheds can be fitted up for the reception of wheat, which can be discharged into them from the inland craft, by means of floating elevators, and transferred again to the outward vessels by the same means, when occasion requires.

For connecting the cart traffic with the shore, the plan of ferry scows suggested by Mr. Keefer some years since, will answer a good purpose. One could be established between the outer end of Russell pier and the new wharf, the distance being only 450 feet; a second one at the Island wharf with a distance of 3[illegible] feet; a third at the Grand Trunk pier, with a distance of 450 feet, when lengthened according to the pencil line; and a fourth at Victoria pier, likewise 450 feet, the slack chain could pass around a drum on the scow, worked by a small caloric engine. The passage of the scow across so short a distance would be rapid, and with capacity for ten or twelve loaded trucks at a time, great expedition would result.

A vast addition to the harbour will be made, spreading the expenditure over a number of years according as required, and placing the additional accommodation in a central position with reference to the existing warehouses in the city, having ready access to them through the facilities afforded by the scows, and, moreover, from the revenue derived from the ground rent, being to a certain extent self supporting; in other words, a large share of the interest on the capital employed in the construction, would not be dependent on the ordinary harbour dues, but be realized in another and more equitable manner. A great number of craft would also be brought into the harbour, which at present discharge their freight in the canal basin, without passing the guard lock.

On a careful summing up of the foregoing, the undersigned is of opinion that the interests of the harbour and the commercial community would be best consulted by building the wharves at the foot of the Lachine Canal for the reasons already stated, and then gradually extending plan No. 1 on the Island Shoal, as demanded from time to time by the exigencies of commerce.

CHARLES LEGGE,
Civil Engineer.

MONTREAL, *July*, 15*th*, 1861.

MINUTE OF THE PROCEEDINGS OF THE HARBOUR COMMISSIONERS UPON THE FOREGOING REPORT.

At a meeting of the Board of Harbour Commissioners, held at Montreal, on Saturday, 20th July, 1861.

PRESENT:

Commissioners, H. H. WHITNEY, Esq., *Chairman.*
" The Hon. JOHN YOUNG,
" His Worship the Mayor, C. S. RODIER, Esq.,
" A. M. DELISLE, Esq.,
" EDWIN ATWATER, Esq., President, Board of Trade.

The foregoing Report of Mr. Forsyth, Harbour Engineer, upon the best mode of procuring additional accommodation in the Harbour, and the Memorandum of Mr. Legge, Civil Engineer, on the same subject having been read and finally discussed, and the plans prepared by these gentlemen respectively having been duly examined and considered.

MR. DELISLE, seconded by HIS WORSHIP THE MAYOR, moved the following resolution:

"That while the Harbour Commissioners fully appreciate the talent " and ingenuity displayed in the plan of Mr. Legge, Civil Engineer, re- " commending the wharfing of the shoals from Windmill Point down- " wards, they do not consider that his suggestions, (with the exception " of improving the shoals opposite to the Island wharf, which they will " be prepared to take into consideration, as soon as their means, and " the requirements of trade, may justify their doing so) have in any " respect affected the opinion they have arrived at, that the most pro- " per and judicious mode of improving the harbour, both as respects " the interests of trade generally, and the City of Montreal in particu- " lar, is, the construction of breast wharves in twenty feet water, as " occasion may require, from the Military Hospital downwards, accord- ' ing to the recommendation contained in the Report of Mr. Forsyth, the " Harbour Engineer; the same being considerably cheaper in construc- " tion, and affording all the facilities required by the shipping. And " further that Mr. Forsyth's report be printed and published in pamphlet " form, together with the memorandum furnished by Mr. Legge, alluded " to therein."

To which MR. YOUNG, seconded by MR. ATWATER, moved the following amendment.

"That while it is necessary to increase harbour accommodation in " every part of the harbour where it is required, the wants of the trade " of the port demand greater accommodation than now exists, in proxi- mity with the Lachine canal.

"That until the new wharf now under construction at Victoria pier "shall have been completed, and the action of the river thereon ascer- "tained, it is inexpedient to construct any more wharves below "that point; and from the great expense of cartage from the canal "to wharves constructed as far down as Monarque street wharf "suggested by Mr. Forsyth, it becomes necessary to carry out, at once "the wharves as agreed on with the Grand Trunk Railway Company in "November, 1859, and to commence the wharves on the shoals opposite "to the city, according to the plan suggested by Mr. Legge."

The amendment having been put to the vote, the following division took place.

For..... Mr. Young, and Mr. Atwater.

Against..... Mr. Delisle, and His Worship the Mayor.

The votes being equally divided, Mr. Whitney, the chairman, voted against the amendment, and so it passed in the negative.

The original motion being then put, the following division took place.

For..... Mr. Delisle, and His Worship the Mayor.

Against..... Mr. Young, and Mr. Atwater.

The votes being again equally divided, Mr. Whitney, the chairman, gave his casting vote in favor of the motion and so it passed in the affirmative, and it was resolved accordingly.

It was then moved by MR. DELISLE, seconded by HIS WORSHIP THE MAYOR, and resolved:

"That the Harbour Commissioners are prepared to carry out with "the 'Montreal Terminus Company' the arrangements entered into "in November, 1859, with the Grand Trunk Railway Company for the "establishment of a City Terminus."

It was then moved by MR. YOUNG, seconded by MR. ATWATER, and resolved:

"That the plans of harbour extension, prepared respectively by Mr. "Forsyth, and Mr. Legge, be sent to the Board of Trade Room, for "general reference."

ALEX. CLERK,
Secretary.

H. H. WHITNEY,
Chairman.

REPORT

ON WORKS PERFORMED IN THE HARBOUR OF MONTREAL DURING THE YEAR 1860, WITH SUGGESTIONS FOR FUTURE OPERATIONS AND IMPROVEMENTS, BY

MR. ROBERT FORSYTH,

Harbour Engineer.

Published by order of the Commissioners, in conjunction with the foregoing Report on Harbour Extension.

HARBOUR COMMISSIONER'S OFFICE,
MONTREAL, 31*st December*, 1860.

ALEX. CLERK, ESQ.,
Secretary, Harbour Commissioners of Montreal.

SIR,—In submitting the following Report of the works executed under my direction, in the harbour of Montreal, for the year 1860, I beg to lay before the Harbour Commissioners, a detailed statement of *Repairs*, *Constructions* and *Dredying*, and also suggest such further improvements, in the harbour, as would in my opinion meet the growing requirements of the port, in the best and most economical manner.

HARBOUR REPAIRS.

The general harbour repairs this year have amounted to a little over the usual cost, in consequence of some larger repairs than usual having been executed, viz.: a new bridge over the creek at "Albert pier"; repairing and planking the outer end of siad pier; and putting several courses of timber on the extreme end of "Victoria pier," when the water was at its lowest stage, so as to

put the outer end of that pier in such a state, that the repairs may be continued during comparatively high water in spring, and the wharf made available for the use of vessels lying alongside.

Large repairs are absolutely necessary, owing to the dilapidated state, into which almost all the old pile wharves have fallen, and from the rottenness of the top planking which has been so often repaired and the sleepers are so split and decayed, that they will will not hold the spikes and will have to be thoroughly renewed.

The number of carpenters constantly required to keep these old wharves in ordinary repair, has very much increased the amounts of the paysheets, but, I would observe, the greater portion of the planking used this year, has been sawed out of the sound portions of the old piles removed from "Prince's" and "King's" basins.

The total sum expended this year for harbour repairs, amounts to $5,131.38.

CONSTRUCTIONS.

QUEEN'S BASIN.—The extension of this basin, for the accommodation of "Ocean Steamships," has been finally completed, and it has been deepened to the full depth of 20 feet at lowest water.

Alongside that wharf there is berth-room for two of the largest steamships of the present lines, while a third can have a good stage berth between the two that may be lying close to the wharf.

The total cost of this extension and deepening, amounts to $54,816.53.

ISLAND WHARF.—The greater portion of the Island wharf has been rebuilt with cribwork, sunk in 20 feet water round four sides, and now one side only remains to be dredged and repaired in a similar manner, to make the whole wharf available for the largest class of ships coming into port.

The improvements on this wharf have amounted to $25,536.10.

PRINCE'S and KING'S BASINS.—These works were commenced last May, and have been finally completed in so far as the contractors are concerned. There remains a small portion of the road-making to complete the whole, but the wharf is quite ready for the shipping of the port on the opening of the navigation in 1861,

and will accommodate five of the largest class of sailing vessels with wharf berths, while stage berths for several additional ships, may be had between these former, for the purpose of discharging and receiving cargo from the wharf.

The cribwork forming these basins has been sunk in 20 feet water, although outside, I have only shewn 18 feet water by the plan which I submit herewith. Still, 19 to 20 feet exists almost all along, excepting where deposits have taken place in the process of filling, which deposits will be removed in Spring to make the wharves available to the full depth.

When the cribwork of new constructions is sunk in 20 feet water, I consider the deepening of the harbour, over 18 feet at present, not so necessary as extending the 18 feet accommodation; but the 20 feet depth in the harbour, should be completed simultaneously with the other river improvements, between Quebec and Montreal.

The total cost of these wharves up to the close of season 1860, is $44,391.82.

Military Wharf.—This wharf is not yet quite completed as the work on it was only pushed forward when I had surplus materials from more important works in the harbour. The whole frontage is however completed, so as to be available for the Spring trade, and with the exception of a few yards of material, for finishing and levelling the filling, and a portion of the stone on the top, it is otherwise completed.

I am making a temporary ramp at the lower end of this wharf leading up to the foot of "St. Nicholas Tolentine" street, and the position of it is laid down so as to suit the plans proposed for the extension of the revetment wall, without alteration further than widening.

The cost of this wharf up to this date, is $64,834.19.

Monarque Street Wharf Extension.—The extension of this wharf, two hundred feet, was commenced late this fall and the carpenter work finally completed, and accepted, before the close of the navigation.

There is still a portion of the filling and road making to be done, which will be completed next Spring.

The cost of this extension up to the close of the navigation amounted to $6,302.36.

DREDGING.

The expense and extent of dredging performed in the harbour and ship channel this year will compare favourably with previous years.

I submit the following statement shewing the different locations in which the dredges have been engaged during the past season, and append an abstract of the cost of dredging in different parts of the harbour and channel.

In the absence of an accurate estimate of what the amount may be for the repairs of the dredges this winter, I have made the calculation without these repairs, in all the dredges excepting Nos. Two and Three, which were in the harbour for a very short time in Spring, and the necessary repairs for these have been charged against their work.

The repairs of the dredges last year amounted to an average of four cents ($0·04) per cubic yard of material lifted during the season.

Dredge No. One—Commenced on the 24th April, and worked in the channel opposite to "Wellington pier" until the 2nd May, when she was placed in "Queen's basin," to deepen the upper part of it, and to remove part of the coffer-dam used in constructing its extension. Here she wrought until the 22nd May, when she was removed to take away part of the shoal at the lower end of the Island wharf.

On the 25th June, she was again placed to clear out the channel opposite to "Wellington" and "Nelson" piers, and to deepen the lower end of "Queen's basin" to 20 feet at lowest water. Completing this on the 3rd August, I removed her, to commence and widen the channel opposite to "Jacques Cartier" pier, to 300 feet wide, and 18 feet deep. At this she wrought until the 27th October, when I brought her into Prince's basin, where she wrought until the close of the season, (24th November,) when she prepared for winter quarters.

During the season she wrought 180 working days, and filled 916 scows, without any damage beyond usual tear and wear.

The quantity of material she raised is about 18,320 cubic yards, and the total expense of the dredge, including tender, is about $6,325.20.

DREDGES NOS. TWO and THREE.—Although generally engaged in the improvement of the river, where the dredging has been supposed to be softer than in the harbour, last Spring the Commissioners ordered them to be brought into port for a few weeks, while the water was high, and during the prevalence of easterly gales, as under these circumstances they generally lose considerable time on the Lake St. Peter, and river works.

The experiment, I am happy to say, has been most successful, as will be seen from the statement of the amount of dredging done, and although these dredges were only three weeks in port, still the amount of work performed by them, exceeded my utmost expectations; and instead of only dredging the beds for the cribs, I found in the three weeks appropriation, I could do more, so I made a channel outside the new crib work in "Prince's basin," sufficient to make the wharf available this fall, which I fully demonstrated, by loading the "Symonds," the "Ocean Monarch," and the "Ceres," at said new wharf.

Had the Prince's and King's basin contract been commenced last Spring, with the slow dredges, and without the assistance of the fast dredges Nos. 2 and 3, it would have been impossible to finish the construction of these wharves this year, and it might have involved some considerable time before so much dredging could have been done, as would make these wharves as available as they now are, since there are so many calls for the slow dredges in the channel and other parts of the harbour.

On the opening of the navigation next Spring, all Prince's basin being in a manner serviceable, it will no doubt contribute largely to the harbour revenue, besides accommodating a large portion of the shipping while other parts of the harbour may be undergoing such repairs, as, in my opinion, are absolutely necessary.

In view of the Grand Trunk Railway Terminus being located at "Windmill Point," and in accordance with the agreement entered into between that Company and the Harbour Commissioners,

by which the latter have certain works to do, and a certain quantity of filling to provide, I had arranged with the Assistant Engineer, Mr. Trembicki that the Grand Trunk Railway Company should give the Harbour Commissioners credit for as much dredged material as they could deposit at Windmill Point from the hopper-bottomed scows, during the high water in Spring. In this way I have received credit from Mr. Trembicki, for 3,959 cubic yards, which taken at what the balance of filling may cost the Commissioners, say 25 cents, per yard, is equal to $989.75. Of this sum, $664.00 would be put to the credit of dredges Nos. 2 and 3, which would reduce the cost of their dredging about 4½ cents per cubic yard, on all their work in the harbour.

I may also state that the deposit of this material at Windmill Point costs less (in towage) than what would have been required to take it to the shoals near "St. Helen's Island."

From my experience in dredging in almost every part of the harbour, I find that generally, after a depth of about 14 feet is obtained, the substratum is clean black quicksand, with an occasional deposited *boulder;* otherwise it is perfectly free from stones.

With the assistance of the "stone lifter" when a very large stone is found, not much time is lost, and the dredges receive less damage than while working at Varennes, Lavaltrie or Batiscan.

These dredges actually wrought in port together only 36 working days while the amount charged for them is for 60 days absence. Still with this large extra charge, the estimate compares favorably with the work of the other dredges, as they, during three weeks did as follows: dredge No. Two filled 118 scow loads, and dredge No. Three filled 100 scow loads.

I have carefully computed the capacity of these scows, and find those of dredge No. 2 will contain when full 98 cubic yards, and those of dredge No. 3 only 83 cubic yards.

These scows were loaded as full as it was safe to tow them to the depositing ground, and from the solid nature of the material (*washed black-sand*) I have calculated the former to contain 70 cubic yards and the latter 60 cubic yards, which would make the amount dredged (by scow measurement) 14,200 cubic yards.

This result I have checked by actual measurement, and I find there has been removed 15,214 cubic yards, making the scow

measurement *less* than the actual measurement by 954 cubic yards. Still, I accept the scow measurement ,and my calculations are based thereon, in case of any wash or other incident having altered their bottom since my last survey.

From this data the expense of dredging by these vessels amounts to about sixteen and a half cents (16½) per cubic yard, and assuming that the Railway Terminus will be constructed at Windmill Point, this estimate will de reduced to twelve cents (.12) per cubic yard.

The total expense of these two dredges and their tender for the time they were engaged in the harbour this Spring, amounts to $2,368.06.

I have laid the result of the work done by dredges Nos. 2 and 3 more minutely before you than may appear necessary, but I wish the Commissioners to be fully satisfied that my recommendation last Spring, to bring them into the harbour, (and adopted by them) has been followed by the most satisfactory and conclusive evidence that these fast dredges *can* work in the harbour, and that the harbour *is* capable of being largely and economically extended.

DREDGE NO. FOUR.—Commenced work in Prince's basin on the 19th April, and wrought there until the 18th June, when I removed her to the channel opposite to the Victoria pier, to straighten the north side of the channel to a clear width of 200 feet, and 18 feet in depth. This she completed up to the Island wharf by the 21st July, when I again placed her on the Prince's basin, where she wrought until the close of the season (27th November), cutting off the point of King's basin and widening the entrance below the Island wharf to Prince's basin.

During the season this dredge filled 614 scow loads, equal to about 24,560 cubic yards.

The total cost of working this dredge for the season, including proportion of "tender," is $7,352.45.

SPOON-DREDGE.—This dredge has been engaged in cleaning out portions of the harbour which could not be got at by any of the large dredges. In this respect she is of the greatest value besides in general dredging, she does more work than either dredges No. 1 or 4, and more economically. A considerable part of the

season she has been engaged removing some small banks out of the Military basin, and clearing along the edge of that wharf, where material had been dropped from the scows which were discharged by hand for its filling.

This dredge has not done as much work this season as usual, in consequence of the depth of water in spring, and as she is not strong enough for pushing that work, we had several breaks, and time was lost in having them repaired. She had to work this year in 25 and 26 feet water, while her power is not sufficient to give the machine justice in over 14 to 15 feet water.

The working expenses of the Spoon Dredge for the season have amounted to $2,903.54.

In view of the probable amount of corner dredging which must be done before all our present harbour is repaired and deepened, I consider that if the Commissioners were to construct another "spoon dredge." of more power than the present one, and seeing the number of applications for the use of dredges made to the Commissioners, these could be let out at a very remunerative rate when they could be spared from the harbour works. Should the Commissioners entertain this recommendation, I will submit an approximate estimate of what such a dredge might cost, complete and ready for work.

STONE-LIFTER.—This vessel has been in the harbour all the season, but as she required a large staff of men to work her, and not a great deal of work to be done, I recommended the Commissioners to discharge all the hands, excepting a watchman whose duty would be to keep her at all times ready for work, so that when any of the dredges were foul of a large stone, the stone-lifter could be brought alongside and wrought by the crew of the dredge requiring her services.

The above recommendation was adopted and has been the means of effecting a very large saving to the Trust. Working expenses this year $214.90.

I append detailed statements of the cost of dredging in different parts of the harbour for the year just concluded.

LIGHTING THE WHARVES.—Last spring, on my suggestion, I was ordered to light the wharves with *coal oil*, and the result

has been quite satisfactory, having had good light and no complaints during the season.

Last year considerable inconvenience was experienced for want of the efficient lighting of the harbour when there were only 7 lamps on the wharves. This at a reduced cost was charged by the New Gas Company $579 for the season. This fall I have 22 lamps on the wharves, and the cost for the season, including erection, lighting, and taking down, amounts to only $410.68. Of course several of these lamps were not burned all the season, and the additional ones have been erected on the new wharves. A few more will be required before the whole harbour can be sufficiently lighted.

SUGGESTIONS FOR FUTURE IMPROVEMENTS.

In suggesting what I consider most necessary for the further improvement of the harbour, I would in the first place direct the attention of the Commissioners to the present state of the foot-walk along the revetment wall. I have before suggested this necessary repair, and it has now got into such a state that the whole must be relaid from the Victoria pier to the Canal.

It has got hollow in the middle, the water finds its way down behind the wall, and the whole of the upper section is being pushed over by the wet and frost. However, the relaying of the foot walk may in a manner check the pushing over, but the strength of the wall is not sufficient to resist the pressure of filling behind. It may be necessary at no very distant date to rebuild, at least the upper section, which was first constructed.

On the 19th January, 1859, I submitted a plan and estimate for the extension of the revetment wall, as far as the lower end of the Military wharf, and would again direct the attention of the Commissioners to this improvement, and more particularly to that of making a proper ramp or road way, leading from the lower end of said wharf to the level of Commissioners street.

Since submitting the plan above alluded to, it appears to me that the Commissioners might have the assistance and cooperation of the City Corporation, in carrying out this improvement.

It will be observed that the street in this part of the city is very narrow, and the wharf opposite is very wide. I would pro-

pose that the Harbour Commissioners grant to the Corporation the necessary width for the street, on condition that the latter pay the expense of the filling behind, remove and rebuild the Government slip or ramp, and do all the necessary drainage for the tenements along Commissioners street opposite to the new wall.

REPAIRS OF OLD WHARVES.—The state of all the old pile wharves deserves the attention of the Commissioners, and these from the Jacques Cartier pier to Queen's basin are in a very decayed state. On the plan submitted I have laid down in *red lines* the positions I would recommend the crib work to be sunk, while I would repair the inside of the basins in the same way, keeping in view the widening of the present wharf room to 80 feet from the revetment wall, which would be sufficient for the wharf traffic and a double railway track.

NELSON PIER.—Being built with piles is now very much undermined by the process of dredging, and the top of the piles much decayed. I propose to remove the old piles with the spoon dredge, and sink crib work in the same position, leaving the wharf and basins on either side, the same size as they now are, but to be 20 feet deep.

WELLINGTON PIER.—Might be repaired in the same way on the upper side, as "Nelson pier," but as "Metcalfe basin" is sufficiently large for one inside berth, the crib work on the lower side would be sunk outside of the piles, thereby giving additional top wharf room.

ALBERT PIER.—Might also be repaired in a similar manner, and the cribs sunk outside of the old piles on both sides. As the traffic on this pier is so considerable, I would propose to cover the centre for the roadway with 6 inch tamarac.

SYDENHAM, METCALFE, ELGIN and KING'S BASINS.—Could be repaired with crib work, sunk outside of the piles to the width of 80 feet from the revetment wall as aforesaid.

GRAND TRUNK PIER.—Has been in such a state for some time, that last season the outer end of it was not available, even for the wood trade. The piles at the outer end are broken off, and the planking has been washed away by the ice. Here I would propose to make a large pier as laid down on plan, and suitable for

Ocean vessels, round which there would be berth room for 4 or 5 large ships.

JACQUES CARTIER BASIN.—Being so very narrow, it would not, in my opinion, be advisable to deepen the whole of it for Ocean ships, but I would recommend that the inner end be appropriated to the use of small boats as a "boat basin," as no accommodation of that kind exists at present in the harbour, while the revenue from these would pay the interest of any small accommodation afforded to such boats.

JACQUES CARTIER PIER.—I would not at present extend beyond its present length, as in 1858 a new crib work end was sunk in front. I would however extend the width by sinking cribs in front of the piles on the lower side. The upper side would have to be repaired similar to the Nelson pier. To extend this pier further into the river, would make a very long narrow basin between it and the Grand Trunk pier, which would not be suitable for the general business of the port. The inside of the Island wharf could be dredged and repaired similar to the other wharves.

These are all the pile constructions now in the harbour, and as they must all be removed at no very distant date, I would recommend that none of them should be repaired except with crib work and that these cribs be sunk in 20 feet depth at lowest water.

VICTORIA PIER.—Will no doubt be very much wanted next year, and it will be necessary to put it in proper repair, and all the outer end and part of the lower side have been so much damaged by the ice, that they are not approachable with carts. I embraced the opportunity during the very low water this fall, to raise the timber work so much that, if I have the authority of the Commissioners, I could prosecute the repair while the water is high next Spring. The foregoing embraces all the repairs necessary to put the harbour of Montreal in perfect order, but as these repairs must be spread over a series of several years, I will state those which I consider call for immediate action:

1st. The repairing of the revetment foot walk from the Victoria pier to the Lachine canal.

2nd. Re-cribbing "Wellington pier," "Sydenham" and "Metcalf" basins.

3rd. The extension of "Grand Trunk pier."

This is as much as could be done in the harbour in one season without impeding the trade; and with judicious management in the berthing of ships, these repairs could be carried on without occasioning much inconvenience.

The approximate estimate for these three special repairs is as follows, viz.:

1. Relaying Flagging along wall,.....	$2,638.10
2. Repair of Wellington Pier, &c.,.....	50,000.00
4. Extension of Grand Trunk Pier,.....	33,494.54
	$86,132.64

FUTURE DREDGING.

The deepening of the harbour next season will have to be prosecuted with renewed vigor; for a glance at the accompanying plan will shew the very small amount of accommodation existing for vessels at the draft of water now through Lake St. Peter and other improved parts of the river, viz., 18 feet at lowest summer level. I would therefore beg to lay before the Commissioners what I consider the most expeditious and economical mode of increasing the accommodation for vessels of the above draft of water.

Taking it on supposition that Wellington pier is to be repaired on the opening of the navigation next season, I would place the spoon dredge on the upper side of said pier, and remove the piles to prepare for the crib work. I would place dredge No. 4 on the lower side of same pier in Metcalf basin, to dredge the bed for the crib work, and, if time permitted, I would deepen the whole basin to 18 or 20 feet.

I would place dredge No. 1 to deepen "Elgin basin" to 18 or 20 feet as far as she could work, and would finish up the corners with the spoon dredge.

The total quantity of material required to be dredged from "Elgin," "Metcalf" and "Sydenham basins" to deepen them to 20 feet at lowest water, is as follows, viz:

1. Elgin basin,.....	8,600
2. Metcalf Basin,.....	8,575
3. Sydenham Basin,.....	8,533
Total cubic yards,.....	25,708

From the economical and expeditious manner in which dredges *Nos. two and three* performed their work in the Prince's basin last Spring, I feel compelled to look towards these vessels, to complete the work so successfully commenced by them, and although I should regret to retard the progress of the river work below the Harbour, still as there is scarcity of berth room at the wharves at present for the vessels which can ascend, through the improved channel, I consider the most advisable course for the Commissioners to pursue, is to keep the Harbour, in such a state, as will enable them to avail themselves of the improvements of the channel, between Quebec and Montreal; and these Harbour improvements being of much smaller magnitude than the works below, the former should be in advance of the latter, as what would be the use of a 20 feet channel if there is not a 20 feet Harbour for ships to come to?

During the time these Dredges are in port, and making Harbour improvements, their expenses are wholly paid out of the Harbour Funds, or by special loan if connected with wharf building.

I consider this an advantage to the Provincial Government as so much time would otherwise be lost to the Dredges from the causes I have already alluded to.

By the statement of the cost of dredging, it will be seen that Nos. 2 and 3 dredges work 100 per cent cheaper than Nos. One and Four, besides the immense saving of time, which is of so much importance in our present cramped state for berth room.

If these dredges cannot be brought into port next Spring, it will be impossible, with the slow dredges alone, to make the upper basin, as well as Prince's basin, thoroughly available for the year's business.

The amount of material to be removed to deepen Prince's basin (from the Island wharf to the Grand Trunk pier) is 37,509 cubic yards. This amount is to 20 feet at lowest water, and would probably occupy Dredges Nos. 2 and 3 for about five weeks working time.

After Dredges Nos. One and Four have completed the deepening of the basins, I would place them to widen out the channel to 300 feet as commenced by Dredge No. One this fall, opposite to Jacques Cartier pier, (See Plan.)

As the greater portion of the material lifted by Dredges Nos. One and Four has been used for filling new wharves, and as Dredge No. Four has only two scows, I have found it impossible to keep the dredge working regularly. When in comparatively soft digging, the men are not able to discharge the scows as fast as the dredge can fill them, and consequently the dredge has to stop until the scow is discharged. To work with one hopper-bottomed scow frequently requires the men to stop, and occasions the material to be lost. In this way Dredge No. 4 this year while in soft digging, lost nearly 25 per cent of her time.

To obviate this, I would recommend that a new scow be built for this dredge, so that she can be worked with 2 deck scows and one hopper-bottomed. The deck scows would always have the preference, so as to save the material, while the hopper-bottomed scow would be alongside as a stand by, in case of loss of time. In this way the dredge could be kept constantly working.

I propose that this scow be constructed on a different plan from the others, to make her cost less for towage, than those with the square ends, and I would make the gates of iron so that they would swing out of the well, and when shut be so tight that they would keep all the sand or other material from washing out, as is the case with all our present scows, while a considerable quantity of canvas has to be used for covering the points. A scow of this kind would cost about $1800.00.

I have ascertained the amount of wharfage in the Harbour, from the mouth of the Lachine Canal to the lower end of the Military wharf, and submit the following statement to show its present extent, at the different depths, viz:—

Total amount of wharfage in Harbour:

1	20	feet deep and over.....					1748
2	18	"	and under		20	ft.	1508
3	15	"	"	"	18	"	2219
4	10	"	"	"	15	"	5834
5	00	.....		under	10	"	227
				Total lineal feet.			11,536

Should the dredging and wharf building recommended in this report be carried out next year, the statement of wharfage will be

changed, so that the following will be the probable extent of wharf room, but in this calculation I only place the three upper basins at 18 feet water, in case I might not be able to bring them down to the full depth of 20 feet.

Amount of wharfage after the execution of proposed improvements:

1	20	feet deep and over.....			3293
2	18	" and under.....	20 ft.		2708
3	15	" " "	18 "		....
4	10	" " "	15 "		5505
5	00	.....under	10 "		227
		Total lineal feet.			11,733

While the Commissioners are endeavouring to extend the present wharfage of the Harbour, I beg to direct their attention to the propriety of affording facilities, for more expeditious and economical means of loading, and discharging cargo, as every aid thus afforded adds to the extent of wharfage, in proportion to the facilities so presented.

The Commissioners have before them a plan for Steam Elevators and produce stores, (with milling power if approved of) to be erected on "Prince's" and "King's" basins, where Ocean and Inland craft, may receive and discharge cargo, direct from the store or elevator.

In my communication to you submitting the plan referred to, I gave an approximate estimate of the cost, and stated some of my reasons for supposing the adoption of the scheme or a modification of it, might be of great advantage to the Harbour of Montreal.

Objections may be made to steam power, but as the elevator which I propose, is so close to the Canal, a small quantity of water could be brought from the lower Canal Bridge by a pipe laid along Commissioners Street. In this way should the Commissioners get a grant of the water from the Government, milling power by water could be established in the proposed produce stores, but all the water which would be required for driving the elevators, with a *turbine* wheel, under such a head as we would have at low water, viz. 25 feet 4 inches, would be very small indeed and probably little or no objection would be offered by the Government for such an object.

The more I study this scheme, the more am I satisfied of its vital importance to the Harbour of Montreal, and should the Commissioners not provide accommodation of this sort on our wharves, there is, I doubt not, enough of interest, enterprise and public spirit in Montreal to have the present Canal deepened for Ocean ships, to the manifest detriment of the Harbour in the mean time. Should such an event ever take place, the whole available space round the Canal basin would in my opinion become lined with grain elevators and stores, and the trade of the Harbour proper reduced to simply the market boats and wood and brick barges.

But, when it is susceptible of proof, that permanent grain stores can and may be erected on our present wharves, it will be sometime before there will be any necessity for deepening the Canal for want of accommodation or facilities in the Harbour.

As soon as the Commissioners shall have decided what works they are to construct next year, (if any), I will submit a memorandum, of the way in which the different classes of vessels could be accommodated, with the view of best suiting their several require ments, and so as to interfere the least with progressing improve ments.

As considerable inconvenience has always been experienced in the Harbour, in consequence of there being no regular tide or water gauge placed so that ship Masters and Pilots, might at all times have an approximation of the depth of water on the flats of Lake St. Peter, I propose next spring to erect on the Harbour Light House *a dial water gauge* which will be sufficiently accurate for practical purposes, and I will base the same on observations taken for five or six years.

This will always be an accurate Harbour water gauge, through extraordinary tides and strong gales may, to a slight extent, affect the difference of level between the Harbour of Montreal and Lake St. Peter.

I cannot close this report without testifying to the kind and accommodating manner in which you have always afforded me every necessary information and assistance from your department, also to my Assistant Mr. A. G. Nish, and others of my staff, for their interest in the welfare of the trust, and their anxiety to push for-

ward the Harbour works, which have been brought this Fall, into such a forward and satisfactory state.

Trusting the foregoing remarks may meet with the approval of the Harbour Commissioners,

I have the honour to be,
Sir,
Your obedient Servant,

ROBERT FORSYTH,
Engineer Harbour Commissioners.

STATEMENT SHEWING QUANTITY, LOCATION, AND COST OF DREDGING IN THE HARBOUR OF MONTREAL FOR THE SEASON 1860.

Dredge No. 1, working expenses per day, $21.25 ; including tender, $35.14.

Date.	Working Days.	Scows filled.	Yards per Scow.	Cubic Yards dredged.	Cubic Yards per Day.	Cost per Cubic Yard.	Total Cost.	REMARKS, &c.
April 24 to May 2.	8	24	20	480	60.00	00.58	$281.12	Channel opposite Wellington Pier.
May 2 to May 22.	17	51	20	1020	60.00	00.58½	597.38	Coffer-dam and Queen's Basin.
May 22 to June 25.	28	195	20	3900	139.28	00.25	983.92	Lower end of Island Wharf.
June 25 to Aug. 3.	34	124	20	2480	72.94	00.48	1194.76	Channel opposite Nelson Pier and Queen's Basin.
Aug. 3 to Oct. 27.	69	406	20	8120	117.68	00.29	2424.66	Channel opposite Jacques Cartier Pier.
Oct. 27 to Nov. 24.	24	116	20	2320	96.66	00.36	843.36	Prince's Basin.
	180	916		18,320	101.77	00.34½	$6325.20	

Dredge No. 2, working expenses per day, $40.06 ; including tender, $62,72.

April 24 to May 16.	20	118	70	8260	413.00	00.15 1/10	$1247.26	Prince's Basin.

Dredge No. 3, working expenses per day, $42.13 ; including tender, $70.05.

April 25 to May 12.	16	100	60	6000	375.00	00.18 68/100	$1120.80	King's Basin and entrance to same.

STATEMENT OF COST OF DREDGING (*Continued*).

Dredge No. 4, working expenses per day, $26.23; including tender, $39.74.

Date.	Working Days.	Scows filled.	Yards per Scow.	Cubic Yards dredged.	Cubic Yards per Day.	Cost per Cubic Yard.	Total Cost.	REMARKS, &c.
April 19 to June 18.	51	191	40	7640	149.80	00.26½	2026.74	Prince's Basin.
June 18 to July 21.	29	39	40	1560	53.79	00.74	1152.46	Widening Channel to 200 feet.
July 21 to Nov. 24.	105	384	40	15,360	146.28	00.27	4173.25	Prince's Basin.
	185	614		24,560	132.43	00.29 97/100	$7352.45	

Spoon-Dredge, working expenses per day, $12.74; including tender, $16.50.

April 23 to May 2.	9	42	15	630	70.00	00.23½	$148.50	Queen's Basin (Coffer-dam.)
May 2 to May 17.	13	87	15	1305	100.38	00.16⅓	214.50	Prince's Basin.
May 17 to May 21.	3	24	15	360	120.00	00.13¾	49.50	King's Basin.
May 21 to May 26.	4	23	15	345	86.25	00.19	66.00	Point of King's Basin.
May 26 to June 18.	19	73	15	1095	57.63	00.28½	313.50	Queen's Basin.
June 18 to Aug. 18.	53	243	15	3645	68.77	00.24	874.50	King's Basin, cutting off Point.
Aug. 18 to Sept. 7.	14	94	15	1410	100.70	00.16	230.54	Military Basin.
Sept. 7 to Sept. 13.	..	..	..	....	....	....	....	In Dock for Repairs.
Sept. 13 to Nov. 26.	61	359	15	5385	88.27	00.18½	1006.50	Military Basin.
	176	945		14,175	80.54	00.20½	$2903.54	

In the above statement, no allowance is made for SPRING REPAIRS except on DREDGES NOS. 2 and 3.

On DREDGES NOS. 1 and 4, and the SPOON-DREDGE, about 4 cents per cubic yard will cover SPRING REPAIRS.